APPARATUS AND METHODS TO ACHIEVE A VARIABLE COLOR PIXEL BORDER ON A NEGATIVE MODE SCREEN WITH A PASSIVE MATRIX DRIVE

RELATED U.S. APPLICATION

The present application is a continuation-in-part application of co-pending U.S. application Ser. No. 09/818,081, by Shawn Gettemy, Sherridythe Fraser, and David Lum, entitled "Controllable Pixel Border for a Negative Mode Passive Matrix Display Device," filed Mar. 26, 2001 and which is hereby incorporated by reference, and which itself is a continuation-in-part of co-pending U.S. application Ser. No. 09/709,142, by Canova, et al., entitled "Pixel Border For Improved Viewability of a Display Device," filed Nov. 8, 2000 and which is also hereby incorporated by reference. Both incorporated referenced applications are assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of display screen technology. More specifically, embodiments of the present invention relate to flat panel display screens that are useful in conjunction with portable electronic devices.

2. Related Art

As the components required to build a computer system have reduced in size, new categories of computer systems have emerged. One of the new categories of computer systems is the "palmtop" computer system. A palmtop computer system is a computer that is small enough to be held in the hand of a user and can therefore be "palm-sized." Most palmtop computer systems are used to implement various Personal Information Management (PIM) applications such as an address book, a daily organizer and electronic notepads, to name a few. Palmtop computers with PIM software have been know as Personal Digital Assistants (PDAs). Many PDAs have a small flat display screen associated therewith.

In addition to PDAs, small flat display screens have also been implemented within other portable electronic devices, such as cell phones, electronic pagers, remote control devices and other wireless portable devices.

Liquid crystal display (LCD) technology, as well as other flat panel display technologies, have been used to implement many of the small flat display screens used in portable electronic devices. These display screens contain a matrix of pixels, with each pixel containing subpixels for color displays. Some of the displays, e.g., color displays, use a back lighting element for projecting light through an LCD matrix. Other displays, e.g., black and white, use light reflectivity to create images through the LCD matrix and these displays do not need back lighting elements when used in lit surroundings. Whether color or in black and white, because the displays used in portable electronic devices are relatively small in area, every pixel is typically needed and used by the operating system in order to create displays and present information to the user. Additionally, because the display device is typically integrated together with the other elements of the portable electronic device, the operating systems of the portable electronic devices typically expect the display unit to have a standard pixel dimension, e.g., a standard array of (m×n) pixels is expected.

FIG. **1A** illustrates a typical black and white display screen having a standard size pixel matrix **20** with an exemplary edge-displayed character thereon. The edge-displayed character is the letter "A" and is displayed at the left hand side of the display screen at an arbitrary height. The technology could be either transmissive, transflective or reflective passive matrix display, e.g., liquid crystal display (LCD). In a conventional black and white display screen, the background pixels **26** can be light, e.g., not very dark, and the pixels **24** that make up the edge-displayed character can be dark. Importantly, in a positive mode display LCD, unless driven on, the pixels are white. Therefore, the edge location **28** of the display screen, e.g., between the edge of the matrix **20** and the bezel **22** of the portable electronic device, is typically white. As a result, the left edge of the edge-displayed character, "A," has good contrast and is therefore easily viewed by the user. This is the case regardless of the particular edge used, e.g., left, right, top, bottom, because region **28** surrounds the matrix **20**.

FIG. **1B** illustrates a typical display screen having a pixel matrix **20'** with the same edge-displayed character thereon but using negative mode display LCD technology. In negative mode display LCD, unless driven on, the pixels are black. The edge-displayed character is the letter "A" and is displayed at the left hand side of the display screen at an arbitrary height. In this format, the background pixels **26** can still be light and the pixels **24** that make up the edge-displayed character can still be dark. However, importantly, the edge location **28** of the display screen, e.g., between the edge of the matrix **20'** and the bezel **22** of the portable electronic device, is typically dark in negative mode display LCD. Being dark, the edge region **28** is the same or similar color as the pixels **24** that make up the character. Therefore, the left edge of the edge-displayed character, "A," has very poor contrast and is therefore typically lost as illustrated in FIG. **1B**. This makes reading the edge displayed character very difficult for a user. This is the case regardless of the particular edge used, e.g., left, right, top, bottom, because region **28** surrounds the matrix **20'**.

In an attempt to address this problem, some computer systems do not display edge-located characters to avoid the contrast problems associated with the screen edge. Many desktop computer systems, for example, simply try to avoid the display of edge-located characters on the cathode ray tube (CRT) screen or on a large flat panel display. However, this solution is not acceptable in the case of a small display screen where every pixel is needed for image and information presentation. What is needed is a display that makes maximal use of the available screen pixels while eliminating the problems associated with edge displayed characters in a display format where the pixels of the character are of the same or similar color as the edge region **28**. What is also needed is a solution that is also compatible with standard display screen dimensions, formats and driver circuitry. Further, what is needed is a solution that controls the color of border pixels, yet simplifies the design and lowers the cost of displays by reducing and/or eliminating the dependency of border pixel control on separate timing components.

SUMMARY OF THE INVENTION

Accordingly, embodiments of the present invention provide an electronic device, e.g., a cell phone, portable computer system, PDA, electronic pager, etc., having a screen that makes maximal use of the available screen pixels while eliminating the problems associated with edge displayed characters in display formats where the pixels of the character are of the same or similar color as the edge region. Embodiments of the present invention are particularly useful in negative mode passive matrix LCD displays that utilize a